IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: :
Tomoaki MORI et al. : GROUP ART UNIT: 3711
SERIAL NO: 10/537,777 : EXAMINER: Alvin A. Hunter, Jr.
FILED: June 6, 2005 :
FOR: Golf Club Head and Golf Club:

CERTIFICATION OF TRANSLATION

HONORABLE COMMISSIONER OF PATENTS & TRADEMARKS
P.O. Box 1450
Alexandria, VA 22313-1450

SIR:

I, Kenji IWAMI , residing at c/o ION PATENT of HAYAKAWA-TONAKAI BLDG. 3F., 12-5, IWAMOTO-CHO 2-CHOME, CHIYODA-KU, TOKYO 101-0032 JAPAN declare:

(1) that I know well both the Japanese and English languages;

(2) that I translated the attached document identified as corresponding to Japanese Application No. 2002-355874 filed in Japan on December 6, 2002 from Japanese to English;

(3) that the attached English translation is a true and correct translation of the document attached thereto to the best of my knowledge and belief; and

(4) that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both under 18 USC 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: June 29, 2007

Kenji Iwami

Name: Kenji IWAMI

[TYPE OF THE DOCUMENT] APPLICATION FOR PATENT
[REFERENCE NUMBER] P2002462
[FILING DATE] December 6, 2002
[DESTINATION] Commissioner of the Patent Office
[INTERNATIONAL PATENT CLASSIFICATION] A63B 53/04
[INVENTOR]
[DOMICILE OR RESIDENCE] c/o The Yokohama Rubber Co., Ltd., 36-11, Shimbashi 5-chome, Minato-ku, Tokyo
[NAME] Tomoaki MORI
[INVENTOR]
[DOMICILE OR RESIDENCE] c/o The Yokohama Rubber Co., Ltd., Hiratsuka Factory, 2-1, Oiwake, Hiratsuka City, Kanagawa
[NAME] Norihiko NAKAHARA
[INVENTOR]
[DOMICILE OR RESIDENCE] c/o The Yokohama Rubber Co., Ltd., Hiratsuka Factory, 2-1, Oiwake, Hiratsuka City, Kanagawa
[NAME] Hiroshi SAEGUSA
[INVENTOR]
[DOMICILE OR RESIDENCE] c/o The Yokohama Rubber Co., Ltd., 36-11, Shimbashi 5-chome, Minato-ku, Tokyo
[NAME] Yoh NISHIZAWA
[APPLICANT FOR PATENT]
[IDENTIFICATION NO.] 000006714
[NAME] The Yokohama Rubber Co., Ltd.
[AGENT]
[IDENTIFICATION NO.] 100080159
[PATENT ATTORNEY]
[NAME] Mochitoshi WATANABE
[TELEPHONE NO.] 3864-4498
[AGENT APPOINTED]
[IDENTIFICATION NO.] 100090217
[PATENT ATTORNEY]
[NAME] Haruko MIWA

[TELEPHONE NO.]	3864-4498	
[INDICATION OF CHARGE]		
[DEPOSIT RECORD NO.]	006910	
[AMOUNT OF PAYMENT]	21000 yen	
[LIST OF ATTACHED DOCUMENT]		
[TYPE OF DOCUMENT]	Specification	1 set
[TYPE OF DOCUMENT]	Drawings	1 set
[TYPE OF DOCUMENT]	Abstract	1 set
[GENERAL POWER OF ATTORNEY NO.]	9710081	
[REQUEST FOR PROOF]	YES	

[TYPE OF THE DOCUMENT] Specification

[TITLE OF THE INVENTION] Golf Club Head

[CLAIMS]

[Claim 1]

A golf club head comprising outer shell structure portions including a hosel portion, a face portion, a sole portion, a crown portion, and a side portion; and a joining portion where the crown portion is bonded to the outer shell structure portion, wherein:

a crown member used in the crown portion has an equivalent rigidity not more than 0.8 times as high as that of a sole member used in the sole portion, the equivalent rigidity defined as a product of a thickness and an elastic modulus of a member used in the outer shell structure portion.

[Claim 2]

The golf club head according to claim 1, wherein the members joined together with said joining portion are formed of a different material from one member to another.

[Claim 3]

The golf club head according to claim 1 or 2, wherein the members joined together with said joining portion are each formed of a material selected from the group consisting of a metal, a fiber reinforced metal (FRM), a metal matrix composite (MMC), a fiber reinforced plastic (FRP), and a ceramic matrix composite (CMC).

[Claim 4]

The golf club head according to any one of claims 1 to 3, wherein said crown member is formed of a fiber reinforced plastic (FRP).

[Claim 5]

A golf club head comprising outer shell structure portions including a hosel portion, a face portion, a sole

portion, a crown portion, and a side portion; and a joining portion where a crown member is bonded to the outer shell structure portion, wherein:

the crown member is composed of a plurality of laminated layers of a fiber reinforced plastic, of which at least 50 percent or more layers have a fiber orientation angle of 45 to 90 degrees.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a golf club head of a wood type. More specifically, the present invention relates to a golf club head comprising two or more members.

[0002]

[Prior Art]

Wood type hollow golf club heads manufactured from metals are known conventionally as golf club heads. Those wood type golf club heads have a large volume, allowing an increase in a face area to form a large sweet spot. Consequently, there is a trend at present to provide golf club heads having even larger volume. On the other hand, the weight of the golf club head increases as the golf club head is made larger, and it becomes difficult to swing through the shot when making a golf swing. It therefore becomes necessary to make the golf club head lighter in weight. In order to satisfy the contrary demands for higher volume and lighter weight, hollow wood type metal golf club heads manufactured by using a light metal, such as titanium or a titanium alloy, have been proposed (refer to PATENT DOCUMENT 1 and PATENT DOCUMENT 2, for example).

[0003]

Hollow wood type golf club heads made using this type of light metal satisfy the contradictory requirements for

large volume and light weight. However, the cost of the material itself is high with specialty metals such as titanium and titanium alloys, and therefore there is a problem in that the cost of the golf club head becomes high. In addition, there is also a problem in that limitations are imposed on the workability and the degree of freedom of design such as changing of the material to be used depending on the portion of the golf club head.

[0004]

A golf club head that uses a composite material other than light metals has therefore been proposed (refer to PATENT DOCUMENT 3 and PATENT DOCUMENT 4, for example). In PATENT DOCUMENT 3, a golf club head made from a composite material is manufactured by seating a composite material prepreg sheet within a molding die. Further, in PATENT DOCUMENT 4, a metal matrix composite material, in which long fibers are laminated on a metal matrix, is formed and used in a face surface.

[0005]

[Patent Document 1]

JP 2002-186691 A

[Patent Document 2]

JP 2002-315855 A

[Patent Document 3]

JP 2001-190719 A

[Patent Document 4]

JP 11-290488 A

[0006]

[Problems to be Solved by the Invention]

However, there are problems with an integral formation method in which a composite material prepreg sheet is seated within a molding die, as in PATENT DOCUMENT 3, in that manufacturing is troublesome and processes involved in

manufacturing become complex. In addition, there is also a problem in that sufficient restitution characteristics cannot be obtained.

[0007]

On the other hand, with a method of joining by welding as in PATENT DOCUMENT 4, there is a problem in that sufficient restitution characteristics and durability cannot be obtained. In addition, there is also a problem in that welding cannot be performed for cases where members that are formed by using different types of metals are joined. It becomes necessary to join the members by mechanical fastening, and this leads to cost increases.

[0008]

The present invention has been made in order to solve conventional problems like those described above. An object of the present invention is to provide a golf club head which has high levels of restitution characteristics and durability, with good balance between the restitution characteristics and the durability, and moreover which can be manufactured at low cost.

[0009]

[Means to Solve the Problems]

In order to achieve foregoing objectives, the present invention provides a golf club head comprising outer shell structure portions including a hosel portion, a face portion, a sole portion, a crown portion, and a side portion; and a joining portion where the crown portion is bonded to the outer shell structure portion, wherein: a crown member used in the crown portion has an equivalent rigidity not more than 0.8 times as high as that of a sole member used in the sole portion where the equivalent rigidity is defined as the product of the thickness and the

elastic modulus of a member used in the outer shell structure portion.

[0010]

In the joining portion, the members joined together with the joining portion may be formed of a different material from one member to another. The members joined together with the joining portion may be each formed of a material selected from the group consisting of a metal, a fiber reinforced metal (FRM), a metal matrix composite (MMC), a fiber reinforced plastic (FRP), and a ceramic matrix composite (CMC). The crown member may be formed of a fiber reinforced plastic (FRP).

[0011]

The present invention also provides a golf club head comprising outer shell structure portions including a hosel portion, a face portion, a sole portion, a crown portion, and a side portion; and a joining portion where a crown member is bonded to the outer shell structure portion, wherein, the crown member is composed of a plurality of laminated layers of a fiber reinforced plastic, of which at least 50 percent or more layers have a fiber orientation angle of 45 to 90 degrees.

[0012]

[Embodiment of the Invention]

A golf club head according to the embodiments of the present invention is described below. Fig. 1 and Fig. 2 are exploded perspective views of a golf club head 1 of the present invention, as well as Fig. 3 is a perspective view of the golf club head 1 of the present invention. As shown in Fig. 3, the golf club head 1 of the present invention is a hollow golf club head which is provided with a crown portion 11, a side portion 21, a sole portion 31, a hosel

portion 51, and a face portion 41 as outer shell structure portions.

[0013]

Structural elements used in the outer shell structure portions are herein referred to as members. For example, a structural element that forms the crown portion 11 is referred to as a crown member for cases where the crown portion 11 is formed by using a discrete structural element. Similarly, a structural element that forms the face portion 41 is referred to as a face member, and a structural element that forms the sole portion is referred to as a sole member. However, for cases where the side portion 21 and the sole portion 31 are formed by integral molding, for example, the term "sole member" refers to a portion of the integrally molded structural element which corresponds to the sole portion 31. Furthermore, structural elements added later such as reinforcing materials are not included among the members.

[0014]

As shown in Fig. 1, among the crown portion 11, the side portion 21, the sole portion 31, the hosel portion 51, and the face portion 41, the crown portion 11 and the face portion 41 are formed by a crown member 10 and a face member 40, respectively. On the other hand, the side portion 21, the sole portion 31, and the hosel portion 31 are formed collectively by a golf club head main body 60 as integrally molded. The crown member 10, the face member 40, and the golf club head main body 60 are separate outer shell constituting members, each as a component of a hollow golf club head. The golf club head 1 is made up by joining these outer shell constituting members together.

[0015]

Among the above described members 10 to 50, the face member 40 and the golf club head main body 60 are formed of a metal, for example, titanium or a titanium alloy, while the crown member 10 is formed of a carbon fiber reinforced plastic (CFRP). The crown member 10 is made by laminating carbon fiber cloth in, for example, 3 to 7 layers, with the orientation direction of them being shifted from one layer to another within a range of 45 to 90 degrees, impregnating the laminate thus obtained with an epoxy resin and so forth and then drying it to obtain a prepreg, cutting the prepreg after the contour of the development of the crown portion 51, and molding the cut prepreg into the form of the crown portion 51 and then curing it. In consequence, the crown member 10 is curved approximately into a shape of part of a spherical surface, as shown in Fig. 1 and Fig. 2. There are no particular limitations placed on the thickness of the crown member 10, and any thickness may be used at which a strength capable of withstanding impacts during ball striking can be maintained. The preferred thickness of the crown member 10 is typically from 0.3 to 2.0 mm. There are no particular limitations placed on the mass of the crown member 10, but it is preferable that the mass of the crown member 10 be at 3 to 10% of the mass of the overall golf club head 1.

[0016]

When the equivalent crown rigidity is defined as the product of the elastic modulus (Young's modulus) in the crown member 10 and the thickness of the crown member 10 and the equivalent sole rigidity is defined as the product of the elastic modulus in the sole portion 31 and the thickness of the sole portion 31, the equivalent crown rigidity is made not more than 0.8 times as high as the equivalent sole rigidity. The elastic modulus as referred

to above is defined as a value obtained in the direction along the intersection line of the crown portion when intersected by a plane perpendicular to the striking surface of the face portion. The ratio of the equivalent crown rigidity to the equivalent sole rigidity, namely the equivalent sole rigidity / equivalent crown rigidity ratio, obtained under such definitions as above may have a value of equal to or less than 0.8 in order to effectively change the initial ballistic characteristics of the golf ball, as described hereinafter. By thus setting the equivalent crown rigidity to be not more than 0.8 times as high as the equivalent sole rigidity, the backspin rate of a golf ball when the golf ball is struck with the striking surface can be reduced, and the launch angle can be increased.

[0017]

Figs. 4(a) and (b) are explanatory diagrams for explaining, in an easy to understand manner, how a golf ball is struck with a golf club. As shown in Fig. 4(a), when a golf ball B is struck, an impact force of the golf ball acts on the striking surface of the face portion 41, and the impact force is transmitted to the crown portion and the sole portion. Now, directing attention to shearing deformations of the crown portion and the sole portion that are generated due to the impact force, the equivalent crown rigidity is not more than 0.8 times as high as the equivalent sole rigidity, and the shearing deformation of the crown portion therefore becomes larger than the shearing deformation of the sole portion. The striking surface of the face portion 41 therefore deforms slightly in such a direction as realizing a larger loft angle. This deformation of the striking surface when impacted by the golf ball affects the backspin rate of the golf ball and the launch angle of the golf ball.

[0018]

Figs. 5(a) to (c) show changes in the backspin rate for cases where the equivalent crown rigidity is changed while keeping the equivalent sole rigidity (113 (GPa·mm)) fixed, for head speeds of 34 m/s, 40 m/s, and 46 m/s. As shown in Figs. 5(a) to (c), although the amount of change differs according to the head speed, it can be understood that the backspin rate decreases due to the reduction in the equivalent crown rigidity in each of the cases.

[0019]

On the other hand, Figs. 6(a) to (c) show changes in the launch angle for cases where the equivalent crown rigidity is changed while keeping the equivalent sole rigidity (113 (GPa·mm)) fixed, for head speeds of 34 m/s, 40 m/s, and 46 m/s. As shown in Figs. 6(a) to (c), although the amount of change differs according to the head speed, it can be understood that the launch angle increases due to the reduction in the equivalent crown rigidity in each of the cases.

[0020]

Further, Figs. 7(a) to (c) show changes in the initial velocity of a golf ball for cases where the equivalent crown rigidity is changed while keeping the equivalent sole rigidity (113 (GPa·mm)) fixed, for head speeds of 34 m/s, 40 m/s, and 46 m/s. As shown in Figs. 7(a) to (c), it can be understood that, in each of the cases, there exists a value of the equivalent crown rigidity at which the initial velocity of a golf ball becomes the maximum.

[0021]

In order to realize the member whose equivalent crown rigidity is as above, it is suitable to employ a composite material (FRP) comprising a fiber reinforced plastic material, such as a carbon fiber reinforced plastic (CFRP)

material having carbon fibers incorporated therein as reinforcing fibers. For example, when the reference direction is defined as a direction along the intersection line of the crown portion when intersected by a plane perpendicular to the striking surface of the face portion, and the reference value is defined as a value of the equivalent rigidity of a five layer composite material obtained by laminating 4 layers of carbon fiber reinforced plastic material, with the orientation angle of them being set alternately to +45 degrees and -45 degrees with respect to the reference direction, and piling the uppermost layer of carbon fiber reinforced plastic material having an orientation angle of 90 degrees with respect to the reference direction onto the laminate formed, the composite material may be so fabricated as to have 7 or 3 layers as set forth in Table 1 below, for instance, and can have an equivalent rigidity of any value from 0.37 to 5.63 times as large as the reference value.

[0022]

Referring now to Table 1, the member composed of 3 laminated layers each having an orientation angle of 0° or 90°, for instance, is formed such that the layers have orientation angles of 90°, 0°, and 90°, from the lowermost to the uppermost layers sequentially. The member composed of 7 laminated layers each having an orientation angle of ±60° or 90° is formed such that the layers have orientation angles of +60°, -60°, +60°, -60°, +60°, -60°, and 90°, from the lowermost to the uppermost layers sequentially. Graphs shown in Figs. 5(a) to (c), Figs. 6(a) to (c), and Figs. 7(a) to (c) can be obtained by manufacturing the golf club head 1 by using such a composite material as set forth in the table in the crown member 10, and performing golf ball

striking tests to measure the initial ballistic characteristics of a golf ball.

[0023]

Table 1

Number of laminated layers	Thickness	Equivalent crown rigidity value			
		Orientation angle 0°, 90°	Orientation angle ±30°, 90°	Orientation angle ±45°, 90°	Orientation angle ±60°, 90°
3	0.51 mm	2.30	1.26	0.56	0.37
5	0.85 mm	3.96	2.39	1.00	0.62
7	1.18 mm	5.63	3.52	1.44	0.87

[0024]

There are no particular limitations placed on the number of fiber reinforced plastic (FRP) layers of which the crown portion is composed. Typically, from 2 to 10 layers are laminated, and it is preferable to laminate from 3 to 7 layers. The balance between the durability and the restitution characteristics can be improved by keeping the number of layers within this range. Further, the laminated layers of fiber reinforced plastic (FRP) are so formed that 50% or more of them have reinforcing fibers incorporated therein with a fiber orientation angle of 45 to 90 degrees with respect to the reference direction (direction in which the orientation angle is zero degrees).

Furthermore, it is preferable that the elastic modulus of the reinforcing fibers to be incorporated in the fiber reinforced plastic (FRP) layers be equal to or less than 35×10^3 kgf/mm^2. A sufficient durability can thus be assured by keeping the elastic modulus in this range. In Table 2 below, values of the equivalent rigidity of various alloy materials are represented as the ratio to the reference

value as described before. The equivalent rigidity of the alloy materials is generally high as compared with that of the laminated composite materials comprising a carbon fiber reinforced plastic material as described above.

[0025]

Table 2

Material	Thickness	Equivalent crown rigidity value
Ti-6-4 alloy	1mm	8.81
SUS	1mm	15.07
Al alloy	1mm	5.32
Mg alloy	1mm	3.37

[0026]

The golf club head main body 60 is an integrally molded member which collectively forms the side portion 21, the sole portion 31 and the hosel portion 51, and is made by, for instance, casting a titanium alloy. As shown in Fig. 1 and Fig. 3, a side face that structures the side portion 21 is provided with a curved shape that bulges to the outside, in conformity with a side surface of a wood type golf club head. On the other hand, an overlap width portion 20a that extends from an upper edge of the side portion 21 is provided with a curved shape that bulges to the outside, in conformity with an outer circumferential edge of the crown portion 11. A layer of an adhesive (not shown) such as an epoxy resin is formed on an upper surface of the overlap width portion 20a. The overlap width portion is bonded to a lower surface of the crown member 10 through the adhesive layer to constitute a joining portion.

[0027]

There are no particular limitations placed on the thickness of the side portion 21, provided that the

thickness allows the side portion to withstand impacts during ball striking. It is preferable that the thickness of the side portion 21 be typically from 0.5 to 2.0 mm.

[0028]

As shown in Fig. 1 and Fig. 3, a surface that structures the sole portion 31 is provided with a curved shape that bulges to the outside, in conformity with a bottom surface of a wood type golf club head. There are no particular limitations placed on the thickness of the sole portion 31, provided that the thickness allows the sole portion to withstand impacts during ball striking. It is preferable that the thickness of the sole portion 31 be typically from 1.0 to 3.0 mm.

[0029]

The face member 40 is formed by trimming a titanium or titanium alloy plate after the contour of the development of the face portion 41 of the golf club head 1, as being accompanied by the overlap width portion 40a on its upper edge, and pressing the trimmed plate so as to form the face portion 41 and the overlap width portion 40a therein. As shown in Fig. 1 and Fig. 3, a surface that structures the face portion 41 is almost planar, in conformity with the striking surface of a wood type golf club head.

[0030]

The overlap width portion 40a that extends from the upper edge of the face portion 41 is provided with a curved shape that bulges to the outside, in conformity with the outer circumference of the crown portion 11. Further, both ends of the overlap width portion 40a are formed having shapes that coincide with the shapes of both ends of the overlap width portion 20a of the side member 20. The overlap width portion 40a thus forms a curved continuous surface together with the overlap width portion 20a. A

layer of an adhesive (not shown) such as an epoxy resin is formed on an upper surface of the overlap width portion 40a. The overlap width portion is bonded to the lower surface of the crown member 10 through the adhesive layer to constitute a joining portion. A crisp sound can be made when a ball is struck by forming the face portion 41 by using a metal.

[0031]

No overlap width portions are formed on a lower end side of the face member and in either lateral surface of the face member 40. There are no particular limitations placed on the thickness of the face member 40, provided that the thickness allows the face member to withstand impacts during ball striking. It is preferable that the thickness of the face member 40 be typically from 1.5 to 4.0 mm. A lower edge of the face member 40 and a front surface of the sole portion 31 are formed having shapes that coincide with each other. The lower edge of the face member 40 and the front surface of the sole portion 31 are joined together by welding, for example. Right and left edges of the face member 40, and right and left edges of the side portion 21 of the golf club head main body 60 are formed having shapes that coincide with each other. The left and right edges of the face member 40 and the left and right edges of the side portion 21 are joined together by welding, for example.

[0032]

It should be noted that the sole portion 31, the side portion 21, and the hosel portion 51 that structure the golf club head main body 60 may also be provided as separate, discrete members. For example, a method may be used in which a single plate of titanium or titanium alloy is trimmed in accordance with a development and pressed so

as to form a sole member and a side member. The sole member, the side member, and a separately formed hosel member are integrated with one another by welding boundary portions of the respective members, or by bonding them together through overlap width portions that extend from outer circumferential edges of the respective members.

[0033]

As shown in Fig. 2, the golf club head 1 is fabricated by bonding the crown member 10 formed of a composite material comprising a carbon fiber reinforced plastic (CFRP) to a golf club head intermediate body 101 formed of titanium or a titanium alloy with an adhesive to join them together.

[0034]

A method of manufacturing the golf club head 1 according to this embodiment is described next. Fig. 8 is a flowchart that shows a procedure for manufacturing the golf club head 1 according to this embodiment. Upon manufacturing the golf club head 1 according to this embodiment, first the golf club head main body 60, in which the side portion and the sole portion are integrated, is manufactured by casting a titanium alloy, for example 6-4Ti (step 1). Once the golf club head main body 60 is manufactured, the face member 40 is joined to the face portion 41 of the golf club head main body 60 by welding, for example (step 2). The golf club head intermediate body 101 in which the face member 40 is welded to the golf club head main body 60 can thus be obtained.

[0035]

The crown member 10 is manufactured in parallel with the manufacture of the golf club head intermediate body 101. A carbon fiber reinforced plastic (CFRP) sheet (hereinafter referred to as "CFRP sheet") is first prepared

in order to manufacture the crown member 10. The CFRP sheet is cut into a desired shape with a desired fiber orientation direction. For example, in this embodiment, the sheet is cut into a shape which the crown member 10 will take when developed. From three to seven layers of the CFRP sheet having fiber orientation directions of 45 to 90 degrees, for example, are then laminated, thus obtaining the crown member 10.

[0036]

Next, the crown member 10 thus formed is set within a die, that is, a die provided with a curved surface corresponding to the final shape of the crown member 10, and cured at a predetermined temperature and a predetermined pressure to bond the member itself (step 3). In this bonding process, the crown member is molded under an internal pressure by maintaining it at 155°C for 15 minutes while applying an internal pressure of 3 to 8 kg/cm^2, for example, and postcured by further maintaining it at a temperature of 135°C for one hour. A resin that structures the matrix of the CFRP used in forming the crown member 10, such as an epoxy resin, functions as an adhesive in this embodiment. An unpainted golf club head is thus obtained by the processes described above.

[0037]

Not only an upper portion of the golf club head 1 can be made lighter, but also the center of gravity of the golf club head 1 can be lowered by forming the crown portion 11 by using a CFRP. Further, by forming the crown portion 11 by using a CFRP to thereby control the elastic modulus of the crown portion 11, various types of golf club heads can be provided which allow modifications of the coefficient of restitution of a struck golf ball. In addition, golf club heads varying in the shape of the crown portion 11,

including those having a crown portion with a complex curved surface, can be manufactured easily and at low cost. Furthermore, as discussed hereinafter, golf club heads that are provided with crown portions having high durability, such as impact resistance and environmental resistance, can be provided.

[0038]

Before bonding the crown member 10, it is preferable to perform a surface roughening treatment such as blasting on each surface of the overlap width portions 20a and 40a, and on the lower surface of the outer circumferential edge of the crown member 10 that is bonded thereto. A joining portion having a high mechanical strength can thus be formed by performing the surface roughening treatment on the surfaces to be joined together.

[0039]

The adhesives such as epoxy resins, urethane resins, acrylic resins, and cyanoacrylate resins can be given as examples of adhesives used for bonding individual members. It is preferable that the joining portion thus formed by the adhesive, the part of the crown member 10, and the overlap width portions 20a and 40a be provided with a tensile shear strength equal to or greater than 200 kgf/cm^2. It is more preferable that the joining portion has a tensile shear strength equal to or greater than 200 kgf/cm^2 after being left to stand for two weeks in an environment with a temperature of 50°C and a relative humidity of 95%. By forming the joining portion having a high tensile shear strength equal to or greater than 200 kgf/cm^2, a golf club head provided with superior durability can be obtained.

[0040]

For example, a method in which the width of the overlap width portions 20a and 40a is set to 5 to 20 mm, or the area of the overlap width portions 20a and 40a is set to 1,500 to 4,500 mm^2 can be used to obtain the joining portion provided with such a tensile shear strength as above.

[0041]

Deburring is performed by using abrasive paper or the like on the golf club head 1 thus formed (step 4). A primer such as nylon is applied before painting is performed according to a predetermined pattern (step 5). The golf club head 1 is thus obtained as such a finished product as is shown in Fig. 3.

[0042]

The golf club head 1 of this embodiment is provided with a hollow structure, as is clear from Fig. 1. By thus making the golf club head hollow, the golf club head itself can be made lightweight. Further, the golf club head can be easily manufactured by bonding thin plates of metals and composite materials. A member composed of CFRP is used in this embodiment as the crown member 10, and it is preferable to structure the golf club head by using a member composed of fiber reinforced plastic (FRP), which constitutes 4% or more of the golf club head on the basis of mass, and a member composed of a metallic material. Further, each of the members that structure the golf club head may also be formed by using fiber reinforced plastic (FRP) and metal. By using a member composed of FRP at a mass ratio to the head of 4% or more, a larger volume and a smaller weight of the golf club head can be achieved concurrently and the initial ballistic characteristics of a struck golf ball, that is, the initial velocity, the launch

angle, the backspin rate, and the like, can be effectively regulated.

[0043]

As described above, the golf club head 1 of the present invention is structured by manufacturing the crown member 10, the golf club head main body in which the side portion 21, the sole portion 31 and the hosel portion 51 are integrated, and the face member 40 individually and joining them together. The thickness of each member can therefore be selected. Structural portions on which an impact force does not act directly during ball striking, for example the side portion 21 and the sole portion 31, may be molded relatively thin. A larger weight margin can thus be obtained for the golf club head 1 compared to conventional golf club heads that are formed by integral molding, and a wider variation in design is allowed.

[0044]

On the other hand, the outer circumferential edges of the side portion 21 and the face member 40 are provided with the overlap width portions 20a and 40a, respectively. An adhesive is applied to the overlap width portions 20a and 40a. The golf club head intermediate body 101, that comprises the golf club head main body 60 in which the side portion 21, the sole portion 31, and the hosel portion 51 are integrated and the face member 40, is thus joined with the crown member 10 by bonding. The area of the joining portion formed by an adhesive layer (bonding layer) as well as the crown member 10 and the overlap width portions 20a and 40a between which the bonding layer is sandwiched is larger compared to a join by welding or screwing. Moreover, relatively thin portions exist over the entire joining portion, without the thickness thereof increasing discontinuously. Stress during ball striking can therefore

be dispersed, without concentrating. In addition, the adhesive layer itself functions as a buffer material, and therefore the adhesive layer absorbs the impact during ball striking. Consequently, a sufficient mechanical strength can be obtained even though the thickness of the plate materials to be used is reduced.

[0045]

The golf club head 1 can thus be made lightweight while maintaining its mechanical strength, and therefore the volume of the golf club head can be increased up to 300 to 580 cc, while maintaining its weight almost the same as that of conventional golf club heads, and the area of the sweet spot can be made larger. In addition, although an example is described in this embodiment where the golf club head 1 is made by combining two types of materials, namely titanium or a titanium alloy as a metal, and CFRP as a composite material, the golf club head is not limited to this structure. For example, there may be a plurality of members having the joining portion, and the members to be joined together may be formed of one and the same material, or different materials. Moreover, the crown member, the side member, the sole member, the face member, and the hosel member may be formed by using different materials and joined together by using an adhesive. A wider variation in design is thus allowed by using the members different from one another in material, such as formed of different types of metals, in the individual structure portions, or even a golf club head provided with novel characteristics may be provided.

[0046]

It should be noted that the above wording "different types of metals" refers to metals different from one another in kind in the case of simple metals. In the case

of alloys, any two alloys are considered as different types of metals if the percentage value, which is found by comparing the composition ratios of the metallic elements common to both the alloys between the alloys and summing values of the lower ratios selected between the two composition ratios respectively, is less than 20%. For example, when comparing 6-4 titanium alloy (Ti:Al:V = 90:6:4) and 15-5-3 titanium alloy (Ti:Mo:Zr:Al = 77:15:5:3), the value of the sum total described above becomes 80% (77 + 3), and therefore 6-4 titanium alloy and 15-5-3 titanium alloy are not considered as different types of metals.

[0047]

Joining is performed by bonding members together as described above, and therefore a golf club head in which members that are formed by using different types of metals are joined by an adhesive can be produced. In other words, different types of metals that cannot be joined by welding can be combined in forming the golf club head.

[0048]

In addition, examples of the composite material which may be used include those selected from the group consisting of fiber reinforced metals (FRM), in which reinforcing fibers manufactured out of Al_2O_3 are dispersed in a matrix manufactured out of a metal, metal matrix composite (MMC) materials, in which a reinforcing material of carbon fibers is dispersed in a matrix manufactured out of a metal, fiber reinforced plastics (FRP), in which reinforcing fibers manufactured out of an inorganic material are dispersed in a matrix manufactured out of a resin, and ceramic matrix composite (CMC) materials, in which a reinforcing material of SiC fibers is dispersed in a matrix manufactured out of a ceramic.

[0049]

Materials having various characteristics can thus be combined and used, and therefore a wider variation in design is allowed. That is, using materials having specific properties as appropriate can provide a golf club head that is provided with various types of characteristics regarding the initial ballistic characteristics of a golf ball, the location of the center of mass, and the like. Further, using low cost materials as appropriate restrains an increase in manufacturing cost. In addition, joining of different types of composite materials is performed by using an adhesive, and therefore neither a large molding die like that used in the case of integral molding nor large-scale equipment be necessary. A golf club head capable of being manufactured easily and at low cost can therefore be provided.

[0050]

[Examples]

[0051]

Examples of the present invention are described below. Test pieces and test heads were prepared by the methods as below. After performing environmental tests, tensile shear tests were performed on the test pieces, and actual striking durability tests were performed on the test heads.

[0052]

1. Preparation of Test Pieces

[0053]

Test pieces were prepared by using 6-4Ti titanium alloy plates having a length of 100 mm and a width of 25.4 mm. An adhesive was applied to each of two plates, specifically in a region from its one end to a point 13 mm away from the end, and the plates were joined together into a test piece. An epoxy adhesive and an acrylic adhesive

were used as the adhesive. The test pieces were prepared with (TH01 and TH03) or without (TH02 and TH04) a blasting treatment.

[0054]

2. Preparation of Test Heads

[0055]

Test heads were formed by using a carbon sheet bonded to a body made of Ti-6-4 alloy. An epoxy adhesive and an acrylic adhesive were used for bonding. The test heads were prepared with (TH01-H and TH03-H) or without (TH02-H and TH04-H) a blasting treatment.

[0056]

3. Method of Testing

[0057]

The test pieces and the test heads were exposed to an environment with a temperature of 50°C and a relative humidity of 95% for zero or two weeks. After that, each test head was used to strike a golf ball at an initial velocity of 50 m/s so that the ball might impact the face portion of the relevant test head at a point 10 mm above the center of the portion. The number of times the head was impacted by a ball before it was broken was recorded. The maximum number of times of impacting was set to 5,000. The test pieces were evaluated by measuring the adhesion strength (tensile shear strength) of each test piece. Results of the two tests are shown in Table 3 and Table 4, respectively.

[0058]

Table 3

Test Head Durability Test Results (Initial Ball Velocity: 50m/s)

Test head	Adhesive	Materials bonded	Blasting	Environmental Test Conditions	Durability Test Results	
					0 weeks	2 weeks
TH01-H	Epoxy	Ti-6-4 alloy and carbon sheet	Performed	50°C, 95%	More than 5,000	More than 5,000
TH02-H			Not performed		More than 5,000	More than 5,000
TH03-H	Acrylic		Performed		2,650 To breakage	2,100 To breakage
TH04-H			Not performed		1,800 To breakage	1,050 To breakage

Striking point: 10 mm above the center.

[0059]

Table 4

High Temperature, High Humidity Environment Test Results on Titanium Alloy Plates Made From Ti-6-4 Alloy

(50°C, 95%, 0 and 2 weeks)

Test piece	Adhesive	Materials Bonded	Blasting	Environmental Test Conditions	Tensile Shear Test Results	
					0 weeks	2 weeks
TH01	Epoxy	Ti-6-4 alloy and Ti-6-4 alloy	Performed	50°C, 95%	310.5	293.1
TH02			Not performed		239.8	215.9
TH03	Acrylic		Performed		176.1	147.6
TH04			Not performed		121.4	106.2

[0060]

As can be understood from the results set forth in Table 3, the test pieces TH01-H and TH02-H, in which a carbon sheet was bonded to the test heads by the application of an epoxy adhesive, showed no change even after 5,000 hits and thus proved superior in durability. On the other hand, in the case of the test pieces TH03-H and TH04-H, in which a carbon sheet was bonded to the test heads by the application of an acrylic adhesive, the carbon sheet peeled before 3,000 hits so that these were found to have insufficient mechanical strength.

[0061]

Further, as can be understood from the results set forth in Table 4, the test pieces TH01 and TH02 were provided with a tensile shear strength equal to or greater than 200 kgf/cm^2. It was found that the test pieces TH03 and TH04 had a tensile shear strength that is less than 200 kgf/cm^2. It, however, was demonstrated that the test pieces TH02 and TH04, on which blasting was not performed, have environmental test values that tend to be poor relatively to those of the test pieces TH01, TH03 and TH04, on which blasting was performed. It thus proved that it is preferable to perform blasting.

[0062]

(Exemplary Experiment)

[0063]

An experiment described hereinafter was performed in order to verify effects of the bonding of the crown member 10, formed by using any one out of various materials, to the golf club head intermediate body 101. That is, eight test heads (test golf club heads) varying in the material used to form the crown member 10, the orientation direction of reinforcing fibers in the composite material used to

form the crown member 10, and the method of joining the crown member to the golf club head intermediate body 101 were prepared. The rigidity value, the restitution characteristics, and the durability of each of the test golf club heads were investigated.

[0064]

Eight types of golf club heads, CH01 to CH05 and FH01 to FH03, were prepared as the test golf club heads. The materials used to form the crown members of the individual test golf club heads CH01 to CH05 and FH01 to FH03, the orientation angles of reinforcing fibers in the composite materials for the crown members, the rigidity values, the methods of joining the crown member to the golf club head intermediate body, results of restitution tests, and results of durability tests are all shown in Table 5.

[0065]

The orientation angle of the reinforcing fibers was set on the assumption that the orientation angle was zero in the back-to-face direction (struck ball moving direction) and 90 degrees in the toe-to-heel direction (direction parallel to the surface of the face portion). Further, with the crown members of Example 1 to Example 4, orientation angles of 45 to 90 degrees with respect to the direction in which the striking surface was oriented were imparted to one-half or more of all the plies of laminated carbon fiber cloth. Furthermore, the elastic modulus of the carbon fibers was 24×10^3 kgf/mm^2, and the thickness of the carbon fibers was 0.173 mm. In the table, the symbol "CFRP" denotes a carbon fiber reinforced plastic, and the symbol "AFRP" denotes an aramid fiber reinforced plastic. Results shown in Table 5 were obtained when performing the tests described above. The restitution characteristics and

the durability are each more excellent as their indexes set forth in Table 5 are larger.

[0066]

Table 5

Experiment name	Test piece	Member bonded	Forming material	Orientation angle	Equivalent crown rigidity/ equivalent sole rigidity	Joining Method	Restitution characteristics	Durability
Comparative example 1	FH01	Crown member	Ti alloy	-	1.00	Welding	100	100
Example 1	CH01		CFRP	+45° for 2 plies, -45° for 2 plies	0.11	Bonding	116	106
Example 2	CH02		CFRP	0° for 3 plies, 90° for 3 plies	0.64	Bonding	108	102
Example 3	CH03		CFRP	+30° for 1 ply, -30° for 1 ply, +45° for 1 ply, -45° for 1 ply,	0.21	Bonding	112	104
Example 4	CH04		AFRP	0° for 3 plies, 90° for 3 plies	0.32	Bonding	113	104
Example 5	CH05		Mg alloy	-	0.74	Bonding	109	100
Comparative example 2	FH02		CFRP	0° for 4 plies, 90° for 2 plies	0.90	Bonding	102	101
Comparative example 3	FH03		CFRP	+45° for 2 plies, -45° for 2 plies	0.11	Screwing	114	91

[0067]

As is clear from the results set forth in Table 5, when Example 1 to Example 5 (CH01 to CH05) and Comparative Example 1 (FH01) were compared, the restitution characteristics and the durability of Examples 1 to 5, in which bonding with an adhesive was used as the method of joining the crown member and the golf club head intermediate body together, were both superior to those of Comparative Example 1, in which welding was used as the joining method. Thus, the balance between the restitution characteristics and the durability was good. The equivalent rigidity ratio (equivalent crown rigidity / equivalent sole rigidity) was less than 0.8 in each of Examples 1 to 5. In Comparative Example 2, where the orientation direction of the reinforcing fibers was set to zero and 90 degrees, the equivalent rigidity ratio was 0.90, which was higher than that of any of Examples 1 to 5, and only a restitution characteristics and a durability which were as low as those of Comparative Example 1 were obtained. In the case of Comparative Example 3, where screwing was used as the joining method, the durability dropped remarkably, although the equivalent rigidity ratio was 0.11 and the restitution characteristics were improved as compared with Comparative Example 1.

[0068]

In addition, when looking at the results for Examples 1 to 4, it is clear that the restitution characteristics and the durability were both high and there was good balance between the restitution characteristics and the durability when 50% or more in number of the laminated layers of fiber reinforced sheet had a reinforcing fiber orientation direction shifted by 45 to 90 degrees with respect to the struck ball moving direction. The

restitution characteristics tests were performed under a ball speed condition of 160 ft/s. The durability tests were performed under a ball speed condition of 50 m/s, and the striking point was 10 mm above the center of the face portion.

[0069]

[Effects of the Invention]

According to the present invention, the golf club head having high standards of restitution characteristics and durability, with good balance between the restitution characteristics and the durability, can be provided.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] This is an exploded perspective view of a golf club head of the present invention.

[FIG. 2] This is an exploded perspective view of the golf club head of the present invention.

[FIG. 3] This is a perspective view of the golf club head of the present invention.

[FIG. 4] (a) and (b) are diagrams clearly explaining the deformation caused when a golf ball is struck with the golf club.

[FIG. 5] (a) to (c) are diagrams that show changes in the backspin rate of a golf ball with respect to changes in equivalent crown rigidity.

[FIG. 6] (a) to (c) are diagrams that show changes in the launch angle of a golf ball with respect to changes in equivalent crown rigidity.

[FIG. 7] (a) to (c) are diagrams that show changes in the initial velocity of a golf ball with respect to changes in equivalent crown rigidity.

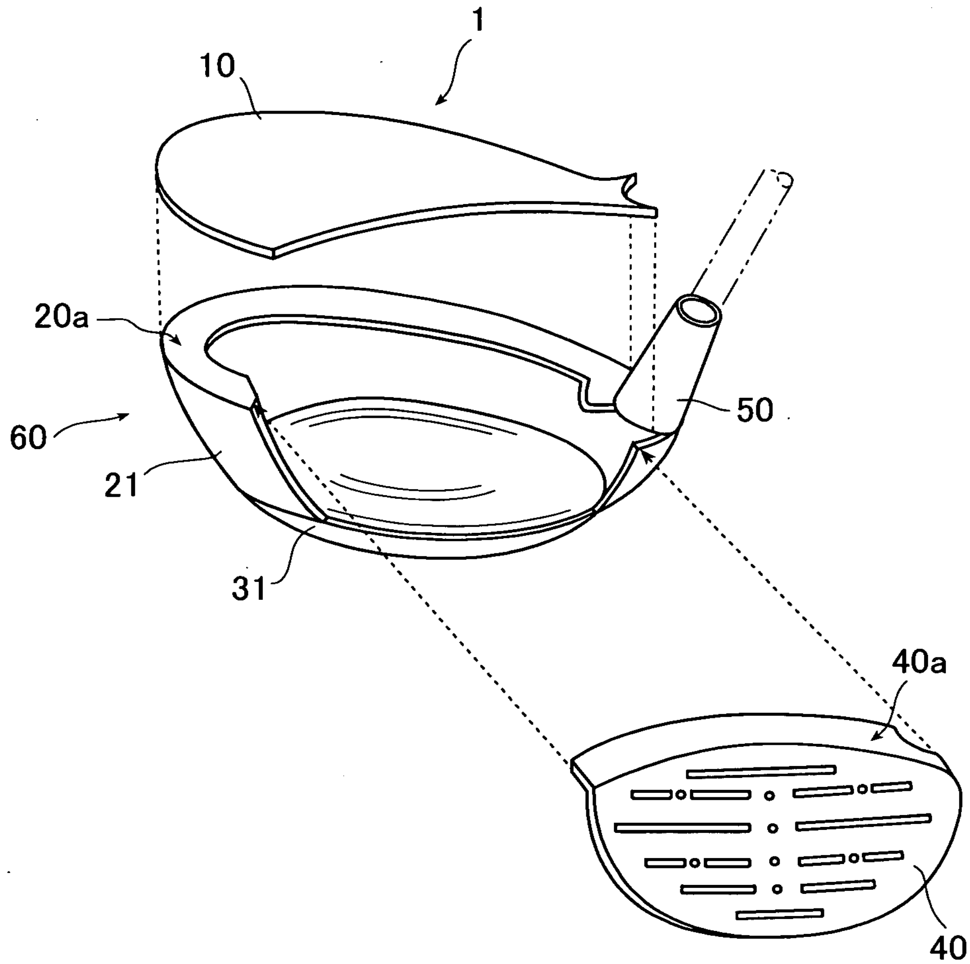
[FIG. 8] This is a flowchart of a manufacturing process of the golf club head of the present invention.

[LEGEND]

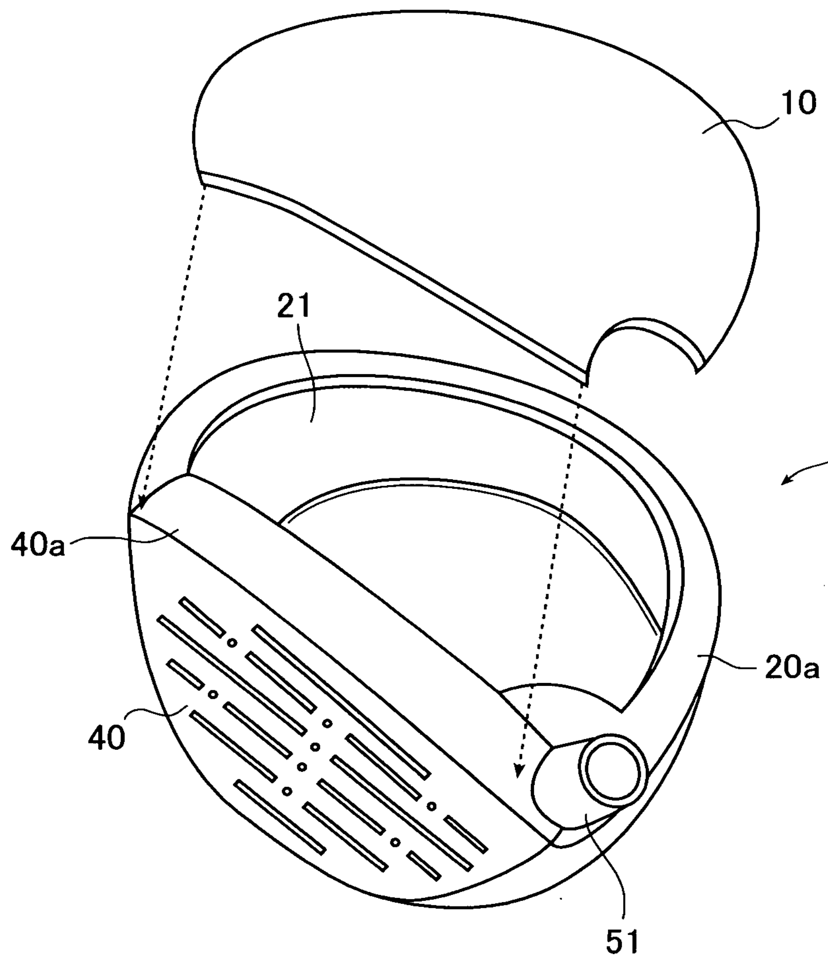
1	golf club head
10	crown member
11	crown portion
20a	overlap width portion
21	side portion
31	sole portion
40	face member
40a	overlap width portion
41	face portion
51	hosel portion
60	golf club head main body

【TYPE OF THE DOCUMENT】 Drawings

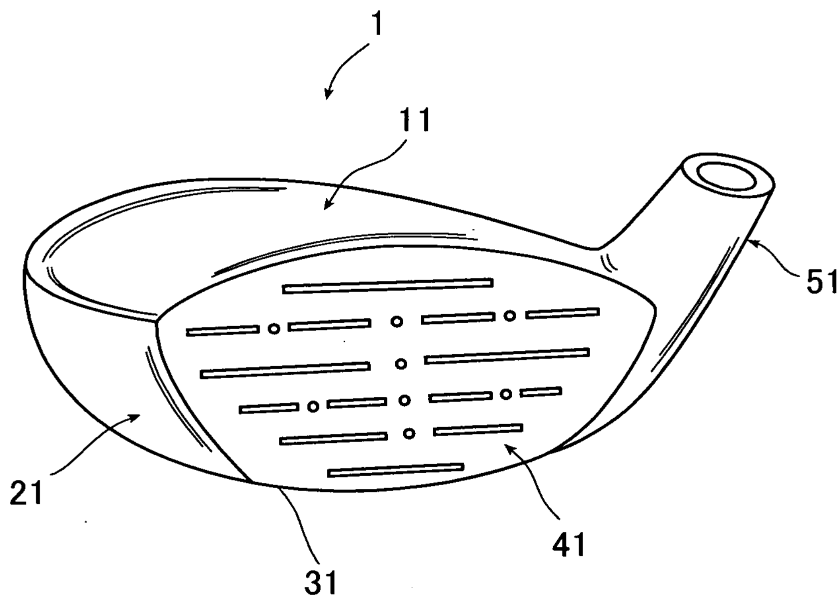
【FIG. 1】



【FIG. 2】

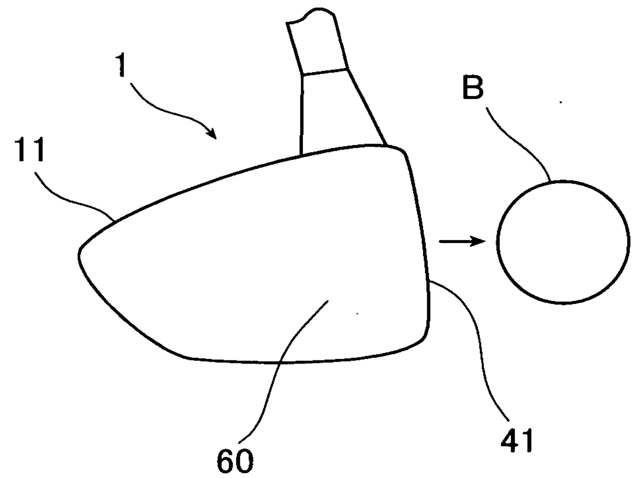


【FIG. 3】

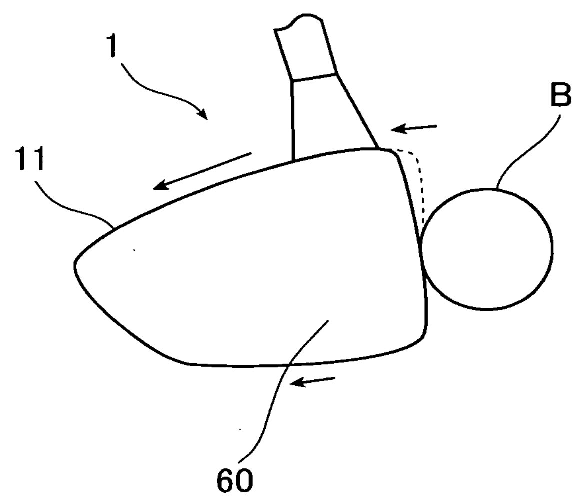


【FIG. 4】

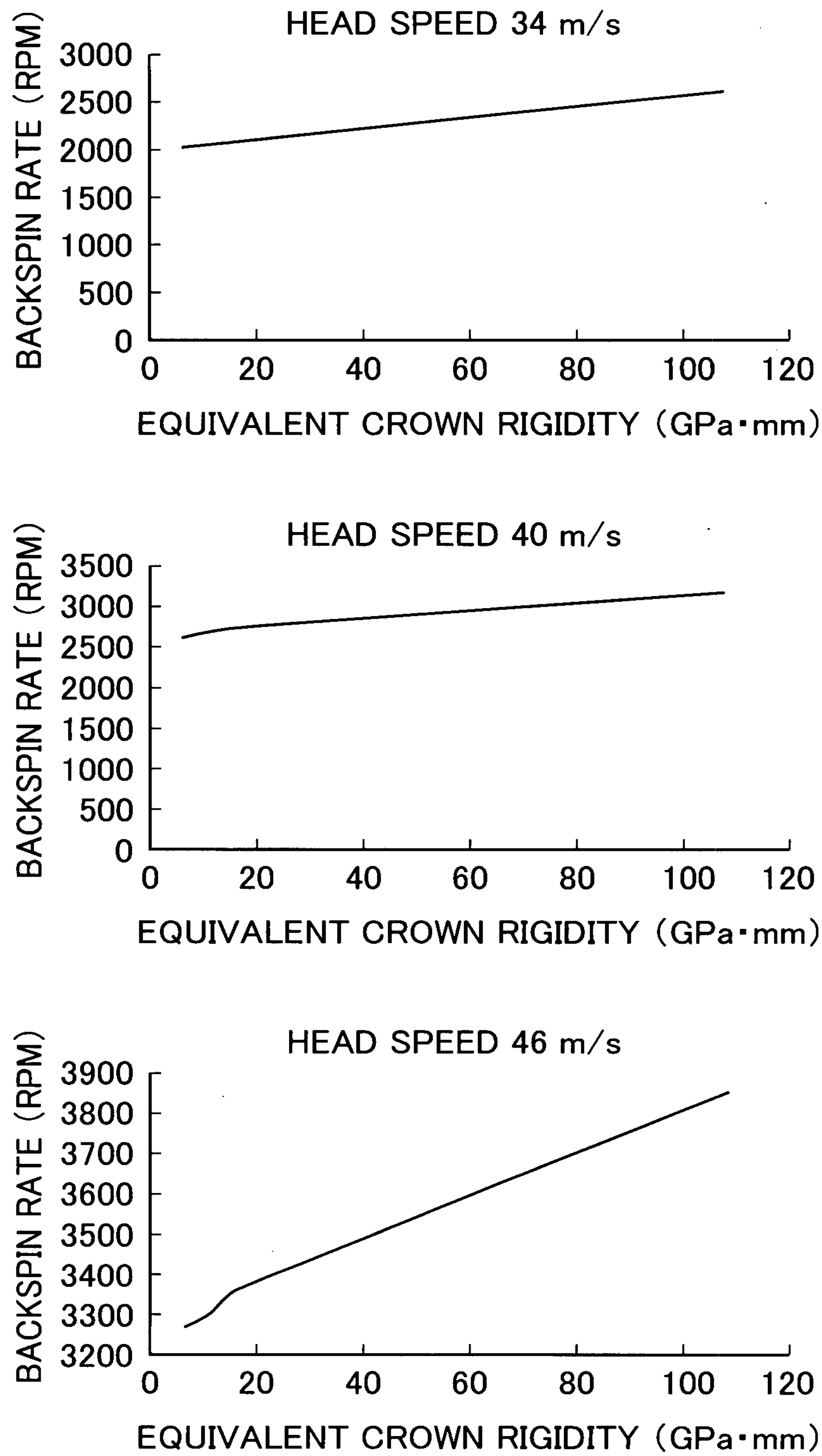
(a)



(b)



【FIG. 5】

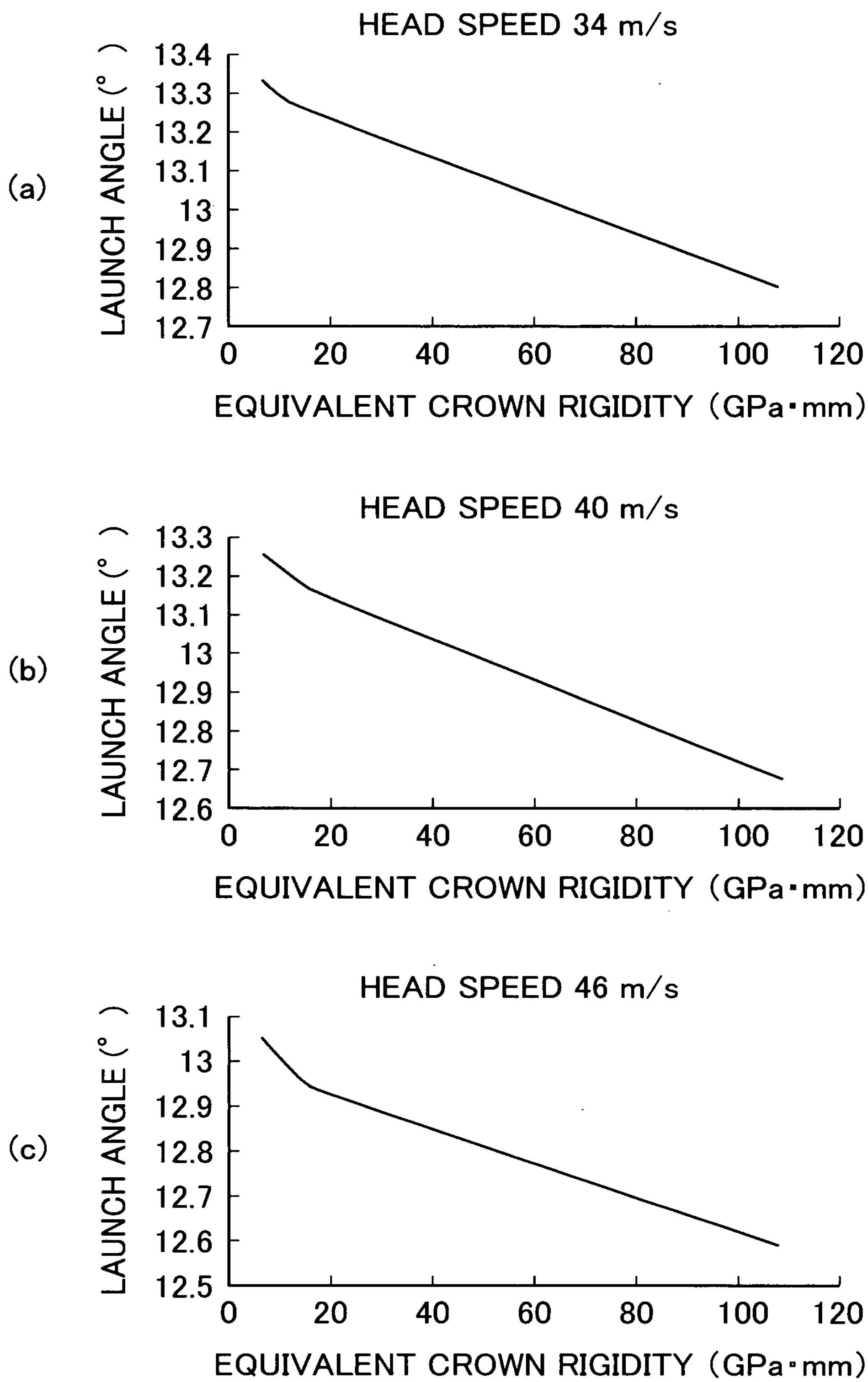

HEAD SPEED 34 m/s
BACKSPIN RATE (RPM)
3000
2500
2000
1500
1000
500
0
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa・mm)
HEAD SPEED 40 m/s
BACKSPIN RATE (RPM)
3500
3000
2500
2000
1500
1000
500
0
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa・mm)
HEAD SPEED 46 m/s
BACKSPIN RATE (RPM)
3900
3800
3700
3600
3500
3400
3300
3200
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa・mm)

(a)

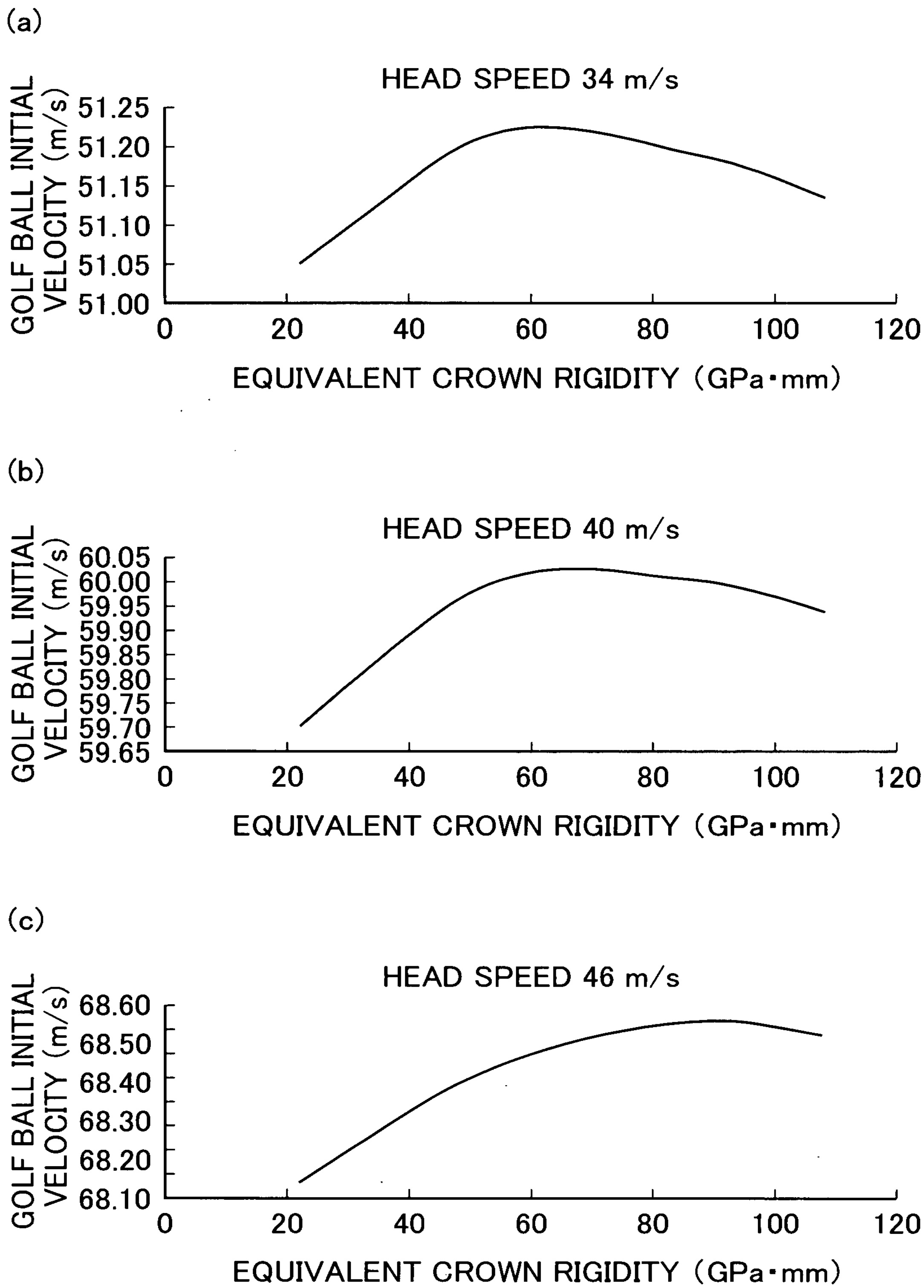
(b)

(c)

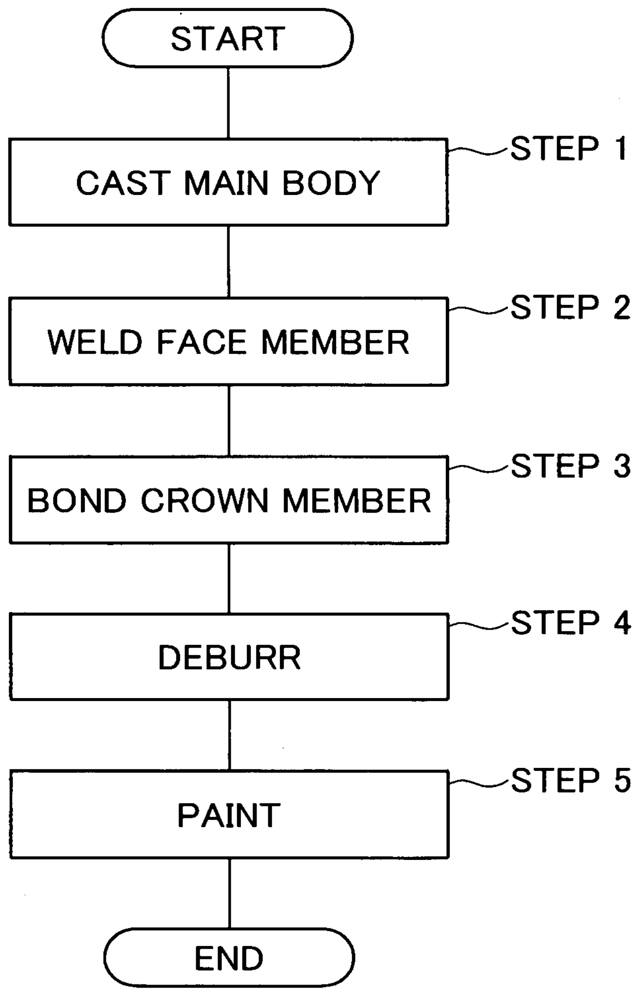
【FIG. 6】


HEAD SPEED 34 m/s
(a)
LAUNCH ANGLE (°)
13.4
13.3
13.2
13.1
13
12.9
12.8
12.7
0
20
40
60
80
100
120
EQUIVALENT CROWN RIGIDITY (GPa·mm)
HEAD SPEED 40 m/s
(b)
LAUNCH ANGLE (°)
13.3
13.2
13.1
13
12.9
12.8
12.7
12.6
0
20
40
60
80
100
120
EQUIVALENT CROWN RIGIDITY (GPa·mm)
HEAD SPEED 46 m/s
(c)
LAUNCH ANGLE (°)
13.1
13
12.9
12.8
12.7
12.6
12.5
0
20
40
60
80
100
120
EQUIVALENT CROWN RIGIDITY (GPa·mm)

【FIG. 7】


(a)
HEAD SPEED 34 m/s
GOLF BALL INITIAL VELOCITY (m/s)
51.25
51.20
51.15
51.10
51.05
51.00
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa·mm)
(b)
HEAD SPEED 40 m/s
GOLF BALL INITIAL VELOCITY (m/s)
60.05
60.00
59.95
59.90
59.85
59.80
59.75
59.70
59.65
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa·mm)
(c)
HEAD SPEED 46 m/s
GOLF BALL INITIAL VELOCITY (m/s)
68.60
68.50
68.40
68.30
68.20
68.10
0 20 40 60 80 100 120
EQUIVALENT CROWN RIGIDITY (GPa·mm)

【FIG. 8】


START
CAST MAIN BODY
STEP 1
WELD FACE MEMBER
STEP 2
BOND CROWN MEMBER
STEP 3
DEBURR
STEP 4
PAINT
STEP 5
END

Japanese Patent Application No. 2002-355874

[TYPE OF THE DOCUMENT] Abstract

[ABSTRACT]

[Object] To provide a golf club head having a high level of restitution characteristics and durability, with the restitution characteristics and the durability being well balanced.

[Means for Solution] A crown member 10, a face member 40, and a golf club head main body 60 in which a side portion 21, a sole portion 31 and a hosel portion 51 are integrated, are manufactured individually. The crown member 10, the golf club head main body 60, and the face member 40 are joined together by a joining portion including an adhesive layer. The crown member 10 has an equivalent rigidity not more than 0.8 times as high as that of the sole portion 31 where the equivalent rigidity is defined as the product of the thickness of each member and the elastic modulus of the member.

[Selected Drawing] FIG. 1